



# The invasive copepod *Lernaea cyprinacea* Linnaeus, 1758 (Copepoda, Cyclopoida, Lernaeidae): first record for Neuquén River, Patagonia, Argentina

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## Abstract

We report the first record of the copepod *Lernaea cyprinacea* (Linnaeus, 1758) parasitizing *Percichthys trucha* (Cuvier & Valenciennes, 1840) in the Neuquén River (Patagonia, Argentina). One specimen of *P. trucha* was found parasitized by two females of *L. cyprinacea*. Our record of *L. cyprinacea* in Neuquén River represents an increase of the known distribution range for this invasive species, which is apparently moving upstream in the Negro River Basin. This is the first record of *L. cyprinacea* in Neuquén Province.

## Key words

Introduced parasite; invasion; freshwater fishes; Los Barreales Reservoir; *Percichthys trucha*; range extension.

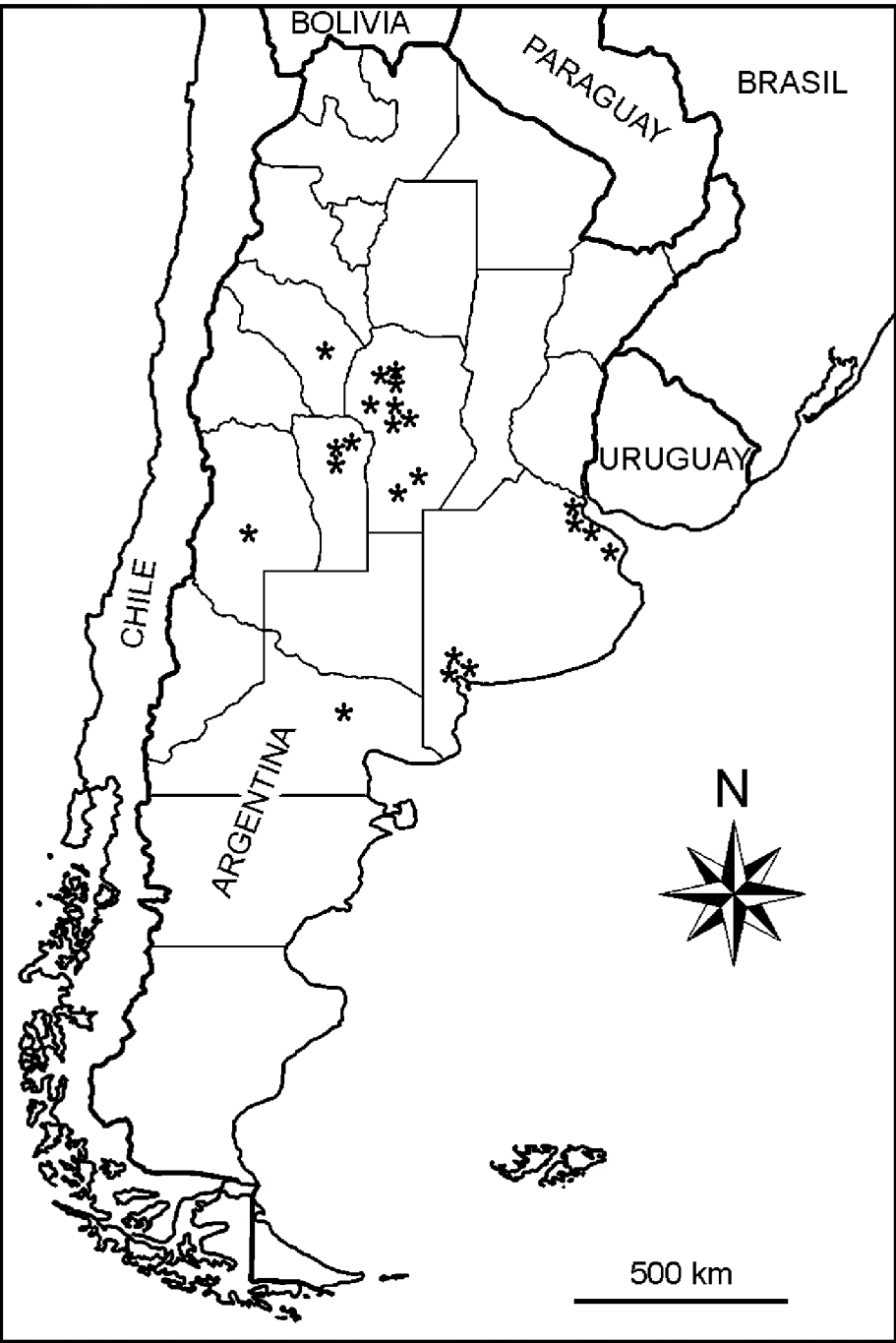
**Academic editor:** Jesser Fidelis de Souza Filho | Received 11 August 2017 | Accepted 8 November 2017 | Published 15 December 2017

**Citation:** Waicheim MA, Blasetti G, Cordero P, Rauque CA, Viozzi GP (2017) The invasive copepod *Lernaea cyprinacea* Linnaeus, 1758 (Copepoda, Cyclopoida, Lernaeidae): first record for Neuquén River, Patagonia, Argentina. Check List 13 (6): 997–1001. <https://doi.org/10.15560/13.6.997>

## Introduction

The cosmopolitan copepod *Lernaea cyprinacea* (Linnaeus, 1758) is a parasite known as anchor worm. It is originally from Eurasia, and was introduced in almost every continent along with cyprinids and has been recorded on more than 100 freshwater fishes from 16 orders (Piasecki et al. 2004, Poulin and Morand 2004). The life cycle of *L. cyprinacea* consists of 3 free-swimming nauplius stages and 5 copepodid stages that can be found, not permanently attached, on the gills and skin of host. The first copepodid stage makes initial contact with a host while the last copepodid stage gives rise to male and female cyclopoids (Kearn 2004, Avenant-Oldewage 2012). After insemination occurred, males die while

females attach permanently to the host tegument and gills. Females have a highly metamorphosed thorax, which enlarges disproportionally and bears 2 conspicuous egg sacs. The cephalic region is formed by 4 lateral processes which are embedded in the host tissue (Avenant-Oldewage 2012). The attachment of copepods on fish causes red sores, and in severe cases or in small fish, it can cause the host's death (Avenant-Oldewage 2012). At present, *L. cyprinacea* is found throughout North and South America, Europe, Asia, Southern Africa, and Australia. In South America it was introduced at the beginning of the 20th century along with imported cyprinids (Piasecki et al. 2004). The published literature on the occurrence of *L. cyprinacea* in Argentina includes records from

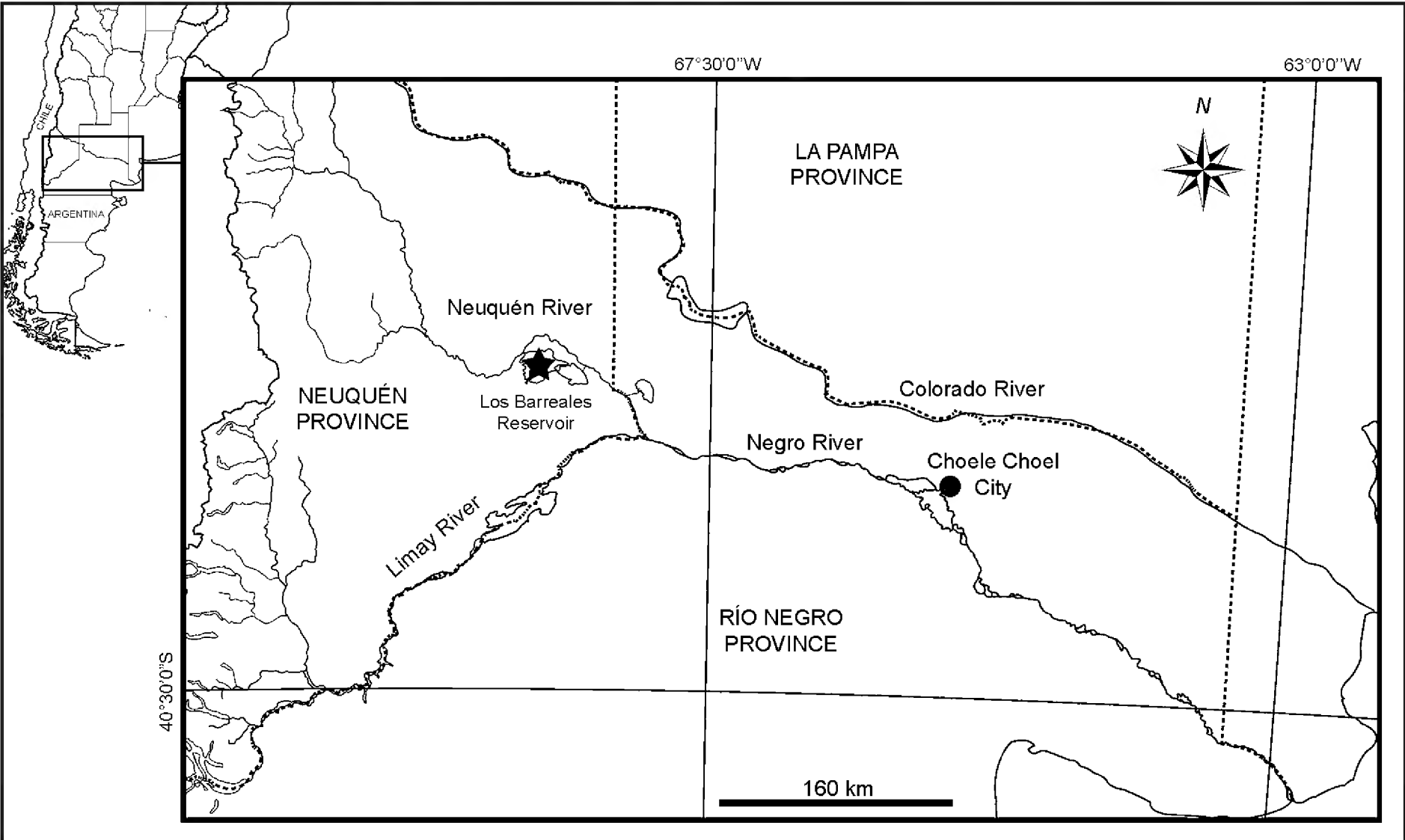


**Figure 1.** Previous published records of *Lernaean cyprinacea* in wild freshwater fishes from Argentina (Vanotti and Tanzola 2005, Mancini et al. 2008a, 2008b, Plaul et al. 2010, Ramallo and Terán 2014). Dots indicate the location of freshwater environments reported.

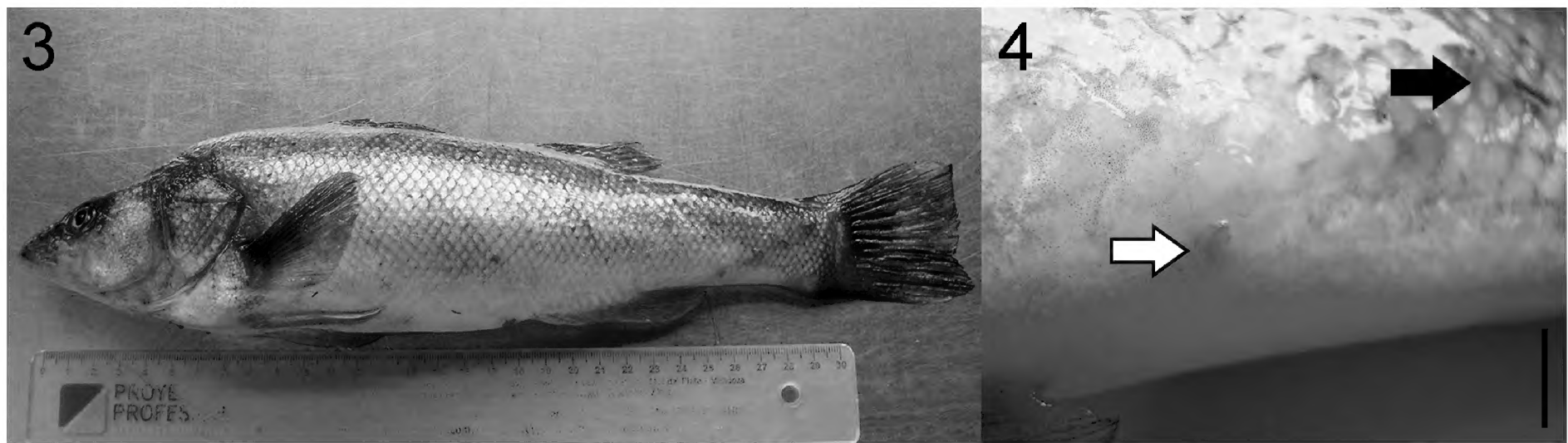
**Table 1.** List of fishes parasitized by *Lernaean cyprinacea* in Argentina (Vanotti and Tanzola 2005, Mancini et al. 2008a, Plaul et al. 2010, Ramallo and Terán 2014).

Order	Species
Cypriniformes	<i>Carassius auratus</i>
	<i>Cyprinus carpio</i>
Characiformes	<i>Astyanax bimaculatus</i>
	<i>Astyanax eigenmanniorum</i>
	<i>Astyanax hermosus</i>
	<i>Astyanax</i> sp.
	<i>Bryconamericus iheringii</i>
	<i>Cheirodon interruptus</i>
	<i>Cyphocharax voga</i>
	<i>Oligosarcus jenynsii</i>
	<i>Corydoras paleatus</i>
	<i>Hypostomus plecostomus</i>
Siluriformes	<i>Rhamdia quelen</i>
Salmoniformes	<i>Oncorhynchus mykiss</i>
Atheriniformes	<i>Odontesthes bonariensis</i>
Cyprinodontiformes	<i>Jenynsia</i> sp.
	<i>Poecilia</i> sp.
Perciformes	<i>Percichthys trucha</i>

several native and introduced wild fishes from La Rioja, San Luis, Córdoba, Mendoza, Buenos Aires, and Río Negro provinces (Table 1, Fig. 1); moreover, it has been recorded in tadpoles and newly metamorphosed frogs in Córdoba province (Salinas et al. 2016). The only record in Patagonia corresponds to parasitized specimens of *Cheirodon interruptus* (Jenyns, 1842) in the Negro River at Choele Choel city (Plaul et al. 2010). We report for the first time the presence of *L. cyprinacea* in 1 specimen



**Figure 2.** Current distribution of *Lernaean cyprinacea* in Negro River Basin, including previous record (black dot) and the new record (black star) for Los Barreales Reservoir in Neuquén River.



**Figures 3, 4.** *Percichthys trucha* collected in Los Barreales Reservoir, Neuquén River. **3.** Lateral view. **4.** Detail of a red sore (white arrow) and adult female of *Lernaea cyprinacea* (black arrow). Scale bar = 0.5 mm.

of *Percichthys trucha* (Cuvier and Valenciennes, 1840) from Neuquén River, in Neuquén Province, Argentina.

## Methods

In April 2016, a sample of fishes was collected, using gill nets, from Los Barreales Reservoir (Fig. 2) in Neuquén River, under permit of the AIC (Autoridad Interjurisdiccional de las Cuencas de los Ríos Limay, Neuquén y Negro). The Neuquén River runs approximately 400 km from the Andes Mountains to the confluence with Limay River, creating Negro River that flows to the Atlantic Ocean. Los Barreales Reservoir integrates 1 of the 4 reservoirs of the Cerros Colorados hydroelectric system, in the lower Neuquén River. Fishes were put on ice and immediately transported to the laboratory. Tegument, opercular and buccal cavities, and gills were checked under stereoscopic microscope. Copepods were counted and carefully removed from the fish tissues using needles and blades. Copepods were identified using Kabata (1979), Robinson and Avenant-Oldewage (1996), Boxshall and Halsey (2004), and Thatcher (2006). A permanent slide mount was made using Hoyer balsam (Thatcher 2006). Drawings were prepared using a microscope with camera lucida. One voucher specimen was deposited in the Colección Nacional de Parasitología, Museo Argentino de Ciencias Naturales Bernardino Rivadavia, Buenos Aires, Argentina (MACN-Pa). Sample for Scanning Electron Microscopy was hydrated before freeze drying, and then the specimen was sputter coated with gold and photographed using the Scanning Electronic Microscope Philips XL30 TMP from the Museo Argentino de Ciencias Naturales Bernardino Rivadavia, Buenos Aires, Argentina.

## Results

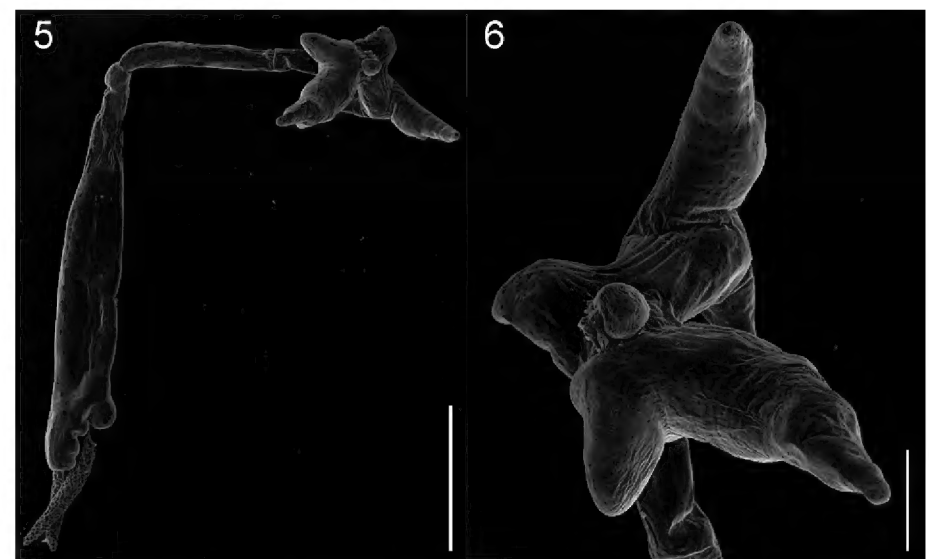
**New records.** Argentina, Patagonia, Neuquén River, Los Barreales Reservoir (38°33'03.27" S, 068°49'52.37" W), recorded by María Agustina Waicheim, April 2016, voucher specimen (MACN-Pa 623), 2 adult females (Figs 5–13).

**Identification.** One female specimen of *P. trucha* (standard length 30 cm; Figs 3, 4) was found infected by 2

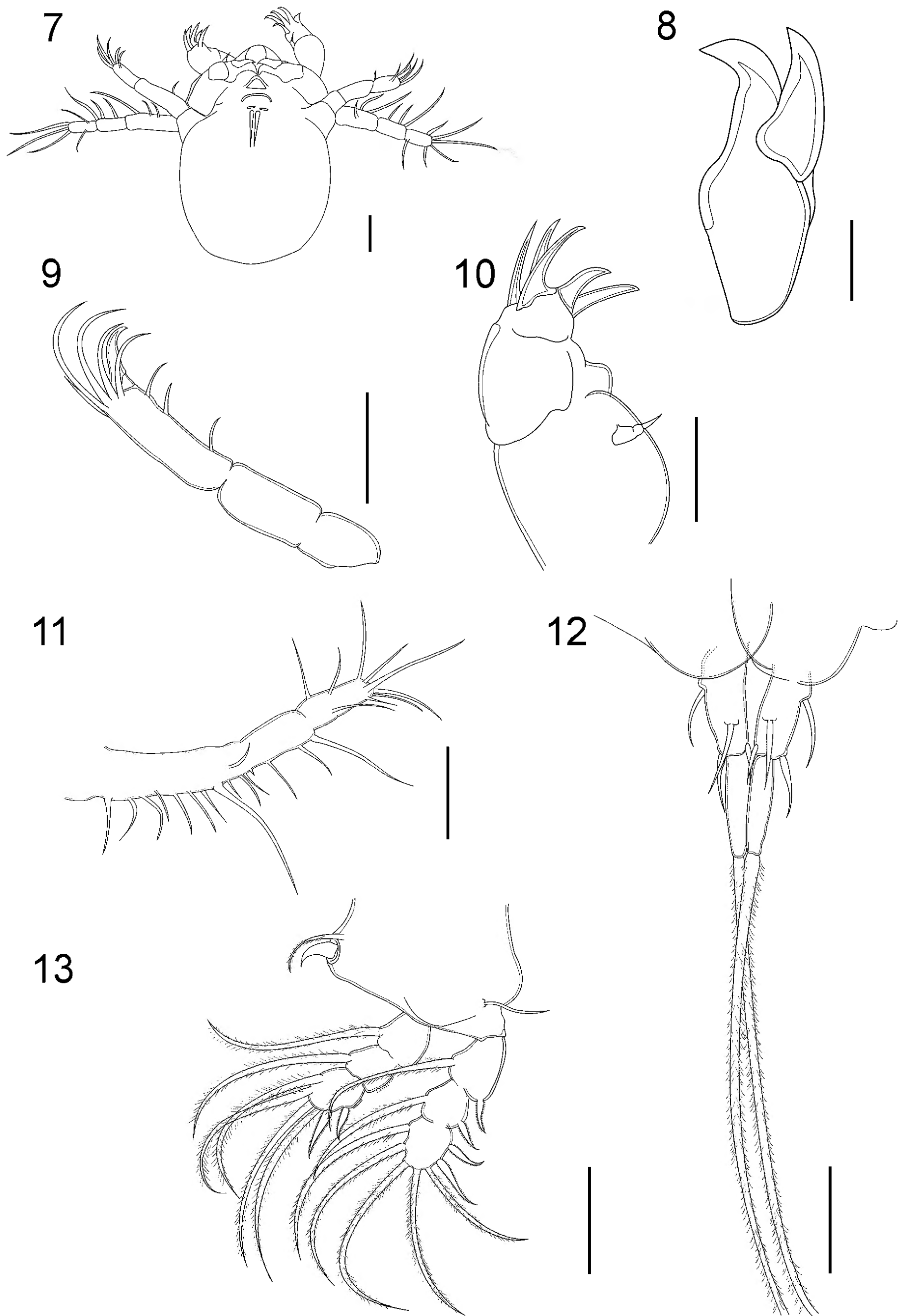
specimens of *L. cyprinacea* (Figs 5–13). One ingravida female was found on caudal peduncle and 1 female bearing egg sacs was attached to the gills. Also, the fish specimen showed several red sores in the tegument (Figs 3, 4). The specimens of *L. cyprinacea* can be distinguished from other species of the genus by the following combination of characters: head with 4 large anchors frequently branched, dorsal pair much larger than ventral, dividing into 2 branches some distance from their bases, ventral pair usually simple, neck consisting of second to fourth leg-bearing segments, more or less circular in cross section, and genital pore near posterior extremity, fourth legs on hind body, abdomen conical usually displaced dorsally, and total length 10–20 mm.

## Discussion

The presence of *L. cyprinacea* in Los Barreales Reservoir indicates that the parasite, which was previously reported in the middle of Negro River (Plaul et al. 2010), has colonized new environments upstream, reaching the reservoirs in Neuquén river. The parasite was introduced into Patagonia probably along with the common carp (*Cyprinus carpio*, Linnaeus 1758). This fish species has colonized all the Negro River and Neuquén and Limay Rivers near their confluence (Waicheim et al. 2014, Crichigno et al. 2016). Carps have not been able to overcome the obstacle posed by dams on these rivers, nevertheless,



**Figures 5, 6.** Scanning electron micrographs of *Lernaea cyprinacea* from the gills of *Percichthys trucha*. **5.** Lateral view. **6.** Lateral view of cephalotorax and anchors. Scale bar = 0.5 mm.



**Figures 7–13.** *Lernaean cyprinacea*. **7.** Cephalothorax, ventral view. **8.** Maxilla. **9.** Antenna. **10.** Maxilliped. **11.** Antennule. **12.** Uropod. **13.** First leg. Scale bars = 50  $\mu\text{m}$ .



*L. cyprinacea* was found upstream the dams, where *C. carpio* is absent, thus it is probable that other small fish species like *C. interruptus*, *Cnesterodon decemmaculatus* (Jenyns, 1842), and *Jenynsia multidentata* (Jenyns, 1842), which are used as bait and for aquarium, are spreading this copepod upstream. In central Argentina, the spread of the copepod is related to the fishing season, when thousands of small fish are sold as bait and transported to different environments (Mancini et al. 2008a). Thus larval stages can be transported away through water resulting in spread of *L. cyprinacea* (Mancini et al. 2008a, Hemaprasanth et al. 2011). No parasitological studies have been done upstream Los Barreales Reservoir; therefore further studies are needed to determine the current distribution of *L. cyprinacea* in Neuquén River Basin.

## Acknowledgements

This study was funded by the following projects: 1) Biodiversidad oculta en ecosistemas acuáticos continentales de la Patagonia. Universidad Nacional del Comahue. UNCo B/187, 2) Invasiones ocultas: Los parásitos y la introducción de peces en la cuenca del Río Negro. CONICET. PIP 2015-2017 GI. The authors thank the Editor of Check List and anonymous referees.

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